SPiRiT and SDD Training Course

Indoor Environmental Quality

Indoor Environmental Quality

- Americans spend 80-90% of their time indoors
- The quality of the indoor environment has a significant impact influence on health, productivity, and quality of life.
- In this case, an ounce of prevention is worth a pound of cure.

Indoor Environmental Quality

The quality of the indoor environment is influenced by many complex factors including HVAC, lighting and occupants.

SPiRiT - IEQ

IAQ Health Implications

- Major health effects of indoor air pollution:
  - Infectious disease: flu, cold, pneumonia (Legionnaires' Disease, Pontiac fever),
  - Cancer, other genetic toxicity, teratogenicity - (Ecotoxicity)
  - Asthma and allergy
  - CNS, skin, GI, respiratory, circulatory, musculoskeletal, and other systemic effects
  - SBS (Sick Building Syndrome)

IAQ Best Practice Concepts

- Relationships between indoor air pollution sources, ventilation, and concentrations are the key.
- Pollutant sources:
  - Outdoor Air, Soil, Water / Building Envelope
  - Building Equipment / Finishes and Furnishings
  - Machines and Appliances / Occupants
  - Occupant Activities / Maintenance and Cleaning

IAQ Best Practice Concepts

- Source control options and strategies:
  - Isolation from outdoors
  - Outdoor air cleaning and filtration
  - Outdoor air ventilation rates and schedules
- Pollutant removal mechanisms:
  - Sinks
  - Ventilation
  - Air Cleaning and Filtration
  - Chemical Transformation

IAQ Best Practice Concepts

- Ventilation system design and operation:
  - Local exhaust for point sources.
  - Air distribution strategy and ventilation effectiveness.
  - Outdoor air ventilation rate.
  - Assembly of all system components.
  - Operator training.
  - Commissioning.

IAQ Best Practice Concepts

- Material Selection and Specification:
  - Quantify major materials and identify important sources.
  - Identify major material selection criteria and alternatives.
  - Obtain maintenance, durability, and expected service life for candidate materials.
  - Determine indoor air implications of installation, removal, and replacement processes.
  - Specify construction practices

IAQ Best Practice Concepts

- Construction:
  - Review submittals to ensure conformance to IAQ performance specifications.
  - Specify and observe construction site practices.
- Maintenance and Operation:
  - Design and operation must be consistent.
  - Need to follow-through the whole process.
  - Design should provide for access to all components of HVAC systems for inspection, repair, and cleaning. Cleaning of surfaces is essential.

IAQ Best Practice Concepts

Change of Use, Renovation, Adaptive Re-use, and De-mounting:

- Modification and Renovation:
  - During construction activities, construction dust, fumes, and vapors must be contained and not allowed to contaminant building surfaces or the air in occupied spaces.
  - Temporary ventilation and isolation barriers should be employed.

IAQ Best Practice Concepts

- Adaptive Reuse:
  - When the use of a space or building is significantly changed, it is essential to determine whether the building systems and layout can support the new activities and occupancy loads.
  - Review record drawings and other documents. If such documents are not available, an engineering assessment should be conducted.
- Demolition:
  - Avoid contamination of occupied spaces or of surfaces that will remain in use or be re-used.

IEQ in LEED 2.0

- SPiRiT addresses both IAQ and general indoor environmental quality.
- There are 2 prerequisites and 10 credits for a total of 17 points.

IEQ Prerequisite 1: Minimum IAQ Performance

INTENT: Establish minimum IAQ performance to prevent the development of indoor air quality problems in buildings, maintaining the health and well being of the occupants.

REQUIREMENT: Meet the minimum requirements of voluntary consensus standard ASHRAE 62-1999, Ventilation for Acceptable Indoor Air Quality and approved Addenda.

IEQ Prerequisite 1: Minimum IAQ Performance

TECHNOLOGIES/STRATEGIES:

- Include proactive design details that will eliminate some of the common causes of indoor air quality problems in buildings.
- Introduce standards into the design process early. Incorporate references to targets in plans and specifications.
- Ensure ventilation system outdoor air capacity can meet standards in all modes of operation.

IEQ Prerequisite 1: Minimum IAQ Performance

- Locate building outdoor air intakes (including operable windows) away from potential pollutants/contaminant sources such as sporulating plants (allergens), loading areas, building exhaust fans, cooling towers, sanitary vents, dumpsters, vehicular exhaust, and other sources.
- Include operational testing in the building commissioning report.
- Design cooling coil drain pans to ensure complete draining.
- Include measures to control and mitigate radon buildup in areas where it is prevalent.
- Limit humidity to a range that minimizes mold growth and promotes respiratory health.

IEQ Prerequisite 2: Environmental Tobacco Smoke (ETS) Control

INTENT: Prevent exposure of building occupants and systems to Environmental Tobacco
Smoke (ETS).

REQUIREMENT: Zero exposure of nonsmokers to ETS by prohibition of smoking in the building, **OR**, by providing a designated smoking room designed to effectively contain, capture and remove ETS from the building.

IEQ Prerequisite 2: Environmental Tobacco Smoke (ETS) Control

TECHNOLOGIES/STRATEGIES:

- Prohibit smoking in the building and/or provide designated smoking areas outside the building in locations where ETS can not reenter the building or ventilation system and away from high building occupant or pedestrian traffic.
- Smoking room testing as described in the ASHRAE Standard 129-1997 is required in the contract documents and critical smoking facility systems testing results must be included in the building commissioning plan and report or as a separate document.

IEQ Credit 1: Carbon Dioxide (CO2) Monitoring

INTENT: Provide capacity for indoor air quality (IAQ) monitoring to sustain long-term occupant health and comfort.

REQUIREMENT: (1 point) - Install a permanent carbon dioxide (CO2) monitoring system that provides feedback on space ventilation performance in a form that affords operational adjustments, AND specify initial operational set point parameters that maintain indoor carbon dioxide levels no higher than outdoor levels by more than 530 parts per million at any time.

IEQ Credit 1: Carbon Dioxide (CO2) Monitoring

TECHNOLOGIES/STRATEGIES:

Install an independent system or make CO_2 monitoring a function of the building automation system. Situate monitoring locations in areas of the building with high occupant densities and at the ends of the longest runs of the distribution ductwork. Specify that system operation manuals require calibration of all of the sensors per manufacturer recommendations but not less than one year. Include sensor and system operational testing and initial set point adjustment in the commissioning plan and report.

IEQ Credit 2: Increase Ventilation Effectiveness

INTENT: Provide for the effective delivery and mixing of fresh air to support the health, safety, and comfort of building occupants.

REQUIREMENT: 1 point - For mechanically ventilated buildings, design ventilation systems that result in an air change effectiveness (E) greater than or equal to **0.9** as determined by ASHRAE 129-1997. For naturally ventilated spaces demonstrate a distribution and laminar flow pattern that involves not less than **90%** of the room or zone area in the direction of air flow for at least **95%** of hours of occupancy.

IEQ Credit 2: Increase Ventilation Effectiveness

TECHNOLOGIES/STRATEGIES:

Design the HVAC system and building envelope to optimize air change effectiveness. Air change effectiveness can be optimized using a variety of ventilation strategies including displacement ventilation, low-velocity ventilation, plug flow ventilation such as under-floor or near-floor delivery, and operable windows. Test the air change effectiveness of the building after construction.

IEQ Credit 3: Construction IAQ Management Plan

INTENT: Prevent indoor air quality problems resulting from the construction/renovation process, to sustain long-term installer and occupant health and comfort.

REQUIREMENTS: Develop and implement an Indoor Air Quality (IAQ) Management Plan for the construction and preoccupancy phases of the building as follows:

IEQ Credit 3: Construction IAQ Management Plan

Credit 3.1 (1 point) During construction meet or exceed the minimum requirements of the Sheet Metal and Air Conditioning National Con-tractors Association (SMACNA) IAQ Guideline for Occupied Buildings under Construction, 1995, AND protect stored on-site or installed absorptive materials from moisture dam-age, AND replace all filtration media immediately prior to occupancy. Filtration media shall have a Minimum Efficiency Reporting Value (MERV) of 13 as determined by ASHRAE 52.2-1999.

IEQ Credit 3: Construction IAQ Management Plan

Credit 3.2 (1 point) Conduct a minimum two-week building flush-out with new filtration media at **100%** outside air after construction ends and prior to occupancy, **OR** conduct a baseline indoor air quality testing procedure consistent with current EPA Protocol for Environmental Requirements, Baseline IAQ and Materials, for the Research Triangle Park Campus, Section 01445.

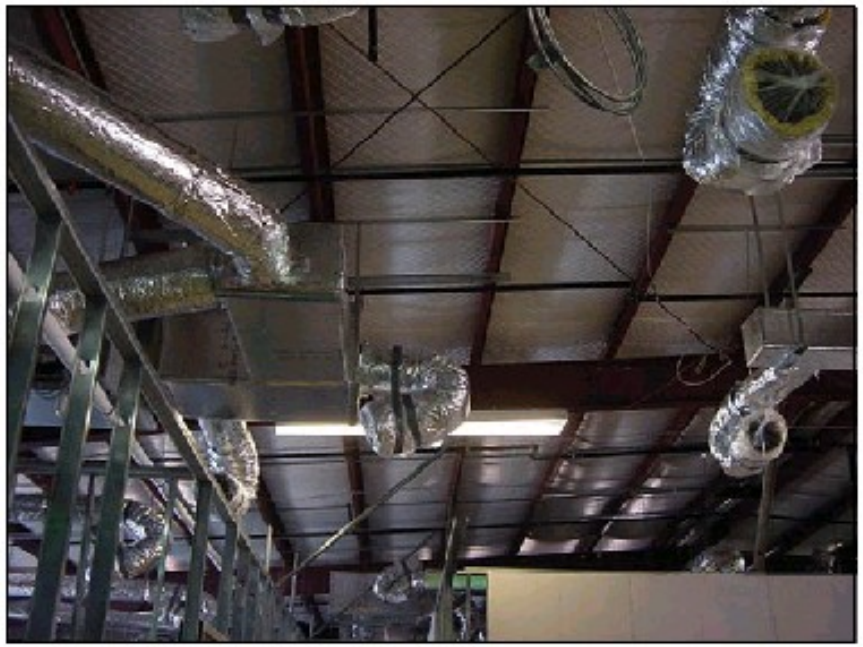
IEQ Credit 3: Construction IAQ Management Plan

TECHNOLOGIES/STRATEGIES:

Adopt an IAQ management plan to protect the HVAC system during construction, control pollutant sources, and interrupt pathways for contamination. Sequence installation of materials to avoid contamination of absorptive materials such as insulation, carpeting, ceiling tile, and gypsum wallboard. Prior to occupancy, perform a two-week building flush out or test the contaminant levels in the building.

Construction IAQ Management

- SMACNA focuses on sheet metal ducting.
- Moisture is a big issue, not to be neglected.
  - Proper phasing of materials.
  - Installing wet materials.
  - Design of drainage plains
  - Failure to cover ducts.



To prevent entry of dust and other contaminants, all HVAC ducts are wrapped with plastic while construction is under way on the Cottonwood Administration Building owned by Intergen. Photo: Brystar Contracting, Beaumont, Texas

IEQ Credit 4: Low Emitting Materials

INTENT: Reduce the quantity of indoor air contaminants that are odorous or potentially irritating to provide installer and occupant health and comfort.

REQUIRMENTS: Meet or exceed VOC limits for adhesives, sealants, paints, composite wood products, and carpet systems as follows:

IEQ Credit 4: Low Emitting Materials

Credit 4.1 (1 point) Adhesives must meet or exceed the VOC limits of South Coast Air Quality Management District Rule #1168 by, **AND** all sealants used as a filler must meet or exceed Bay Area Air Quality Management District Reg. 8, Rule 51.

Credit 4.2 (1 point) Paints and coatings must meet or exceed the VOC and chemical component limits of Green Seal requirements.

IEQ Credit 4: Low Emitting Materials

Credit 4.3 (1 point) Carpet systems must meet or exceed the Carpet and Rug Institute Green Label Indoor Air Quality Test Program.

Credit 4.4 (1 point) Composite wood and agrifiber products must contain no added urea-formaldehyde resins.

TECHNOLOGIES/STRATEGIES: Specify low-VOC materials in construction documents. Ensure that VOC limits are clearly stated in each section where adhesives, sealants, paints, coatings, carpet systems, and composite woods are addressed.

SPiRiT VOC Limits

- Adhesives: Total VOCs 10 mg/m^2/hr
- Sealants
  - Architectural: 250 g/L
  - Roofing materials installations: 450 g/L
- Paints and Coatings:
  - Non-flat - 150 g/L
  - Flat - 50 g/L
- Carpets:
  - Total VOCs - 0.5 mg/m^2/hr
  - Cushion Total VOCs – 1.0 mg/m^2/hr
  - Installation - 150g/L

Pittsburgh Paints Pure Performance is the first zero-VOC paint to replace a standard paint line. Photo: PPG Architectural Finishes, Inc.

IEQ Credit 5: Indoor Chemical and Pollutant Source Control

INTENT: Avoid exposure of building occupants to potentially hazardous chemicals that adversely impact air quality.

REQUIRMENT: (1 point) Design to minimize cross-contamination of regularly occupied occupancy areas by chemical pollutants: Employ permanent entry way systems (grills, grates, etc.) to capture dirt, particulates, etc. from entering the building at all

IEQ Credit 5: Indoor Chemical and Pollutant Source Control

high volume entryways, **AND** provide areas with structural deck to deck partitions with separate outside exhausting, no air recirculation and negative pressure where chemical use occurs (including housekeeping areas and copying/print rooms), **AND** provide drains plumbed for appropriate disposal of liquid waste in spaces where water and chemical concentrate mixing occurs.

IEQ Credit 5: Indoor Chemical and Pollutant Source Control

TECHNOLOGIES/STRATEGIES:

Design to physically isolate activities associated with chemical contaminants from other locations in the building, providing dedicated systems to contain and remove chemical pollutants from source emitters at source locations. Applicable measures include eliminating or isolating high hazard areas; designing all housekeeping chemical storage and mixing areas (central storage facilities and janitors closets) to allow for secure product storage; designing copy/fax/printer/ printing rooms with structural deck to deck partitions and dedicated exhaust ventilation systems; and including permanent architectural entryway system(s) to catch and hold particles to keep them from entering and contaminating the building interior.

IEQ Credit 6: Controllability of Systems

INTENT: Provide a high level of individual occupant control of thermal, ventilation, and lighting systems to support optimum health, productivity, and comfort conditions.

REQUIREMENTS:

Credit 6.1 (1 point) Provide a minimum of **one** operable window and **one** lighting control zone **per 200 SF** for all occupied areas **within 15 feet** of the perimeter wall.

Credit 6.2 (1 point) Provide controls for each individual for airflow, temperature, and lighting for **50%** of the non-perimeter, regularly occupied areas.

IEQ Credit 6: Controllability of Systems

TECHNOLOGIES/STRATEGIES:

Design the building with occupant controls for airflow, temperature, and lighting. Strategies to consider include task lighting, operable windows, and underfloor HVAC systems with individual diffusers.

IEQ Credit 7: Thermal Comfort

INTENT: Provide for a thermally comfortable environment that supports the productive and healthy performance of the building occupants.

REQUIREMENTS:

Credit 7.1 (1 point) Comply with ASHRAE Standard 55-1992, Addenda 1995 for thermal comfort standards including humidity control within established ranges per climate zone.

Credit 7.2 (1 point) Install a permanent temperature and humidity monitoring system configured to provide operators control over thermal comfort performance and effectiveness of humidification and/or dehumidification systems in the building.

IEQ Credit 7: Thermal Comfort

TECHNOLOGIES/STRATEGIES:

Establish temperature and humidity comfort ranges and design the building envelope and HVAC system to maintain these comfort ranges. Install and maintain a temperature and humidity monitoring system in the building to automatically adjust building conditions as appropriate.

http://www.chps.net/manual/index.htm

CHPS – Natural Ventilated Buildings – Comfort Standard

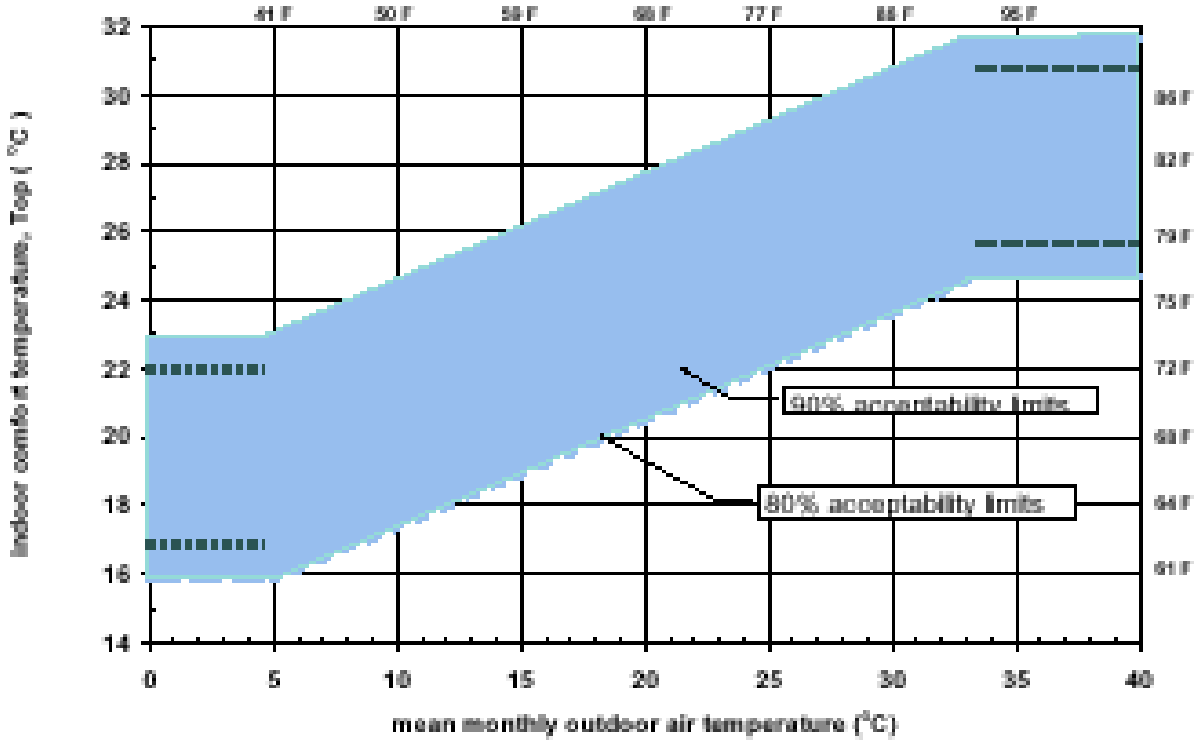


Figure 2. Proposed adaptive comfort standard for naturally ventilated buildings.

IEQ Credit 8: Daylight and Views

INTENT: Provide for the building occupants a connection between indoor spaces and the outdoors through the introduction of daylight and views into the regularly occupied areas of the building.

Campbell Hall, University of Virginia

IEQ Credit 8: Daylight and Views

REQUIREMENTS:

Credit 8.1 (1 point) Achieve a minimum Daylight Factor of 2% (excluding all direct sunlight penetration) in 75% of all space occupied for critical visual tasks. Spaces excluded from this requirement include copy rooms, storage areas, mechanical plant rooms, laundry and other low occupancy support areas. Other exceptions for spaces where tasks would be hindered by the use of daylight will be considered on their merits.

Credit 8.2 (1 point) Achieve direct line of sight to vision glazing for building occupants in 90% of all regularly occupied spaces, not including copy rooms, storage areas, mechanical, laundry and other low occupancy support areas. Other exceptions for spaces where tasks would be hindered by the use of daylight will be considered on their merits.

IEQ Credit 8: Daylight and Views

TECHNOLOGIES/STRATEGIES:

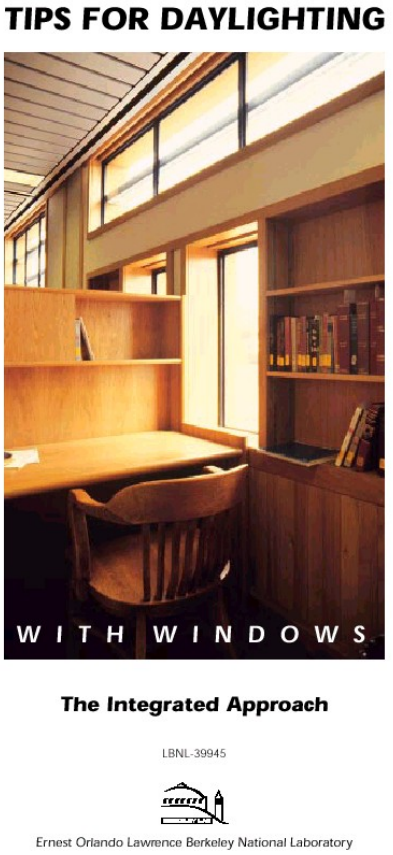
Design the building to maximize daylighting and view opportunities. Strategies to consider include building orientation, shallow floor plates, increased building perimeter, exterior and interior shading devices, high performance glazing, and photo-integrated light sensors. Model daylighting strategies with a physical or computer model to assess footcandle levels and daylight factors achieved.

Daylighting & Views

- Consider early in the design process.
- Difficult to achieve as a retrofit.
- Atriums and stepped designs are effective in large buildings.

Daylighting & Views

- Control glare:
  - Adjustable Blinds
  - Interior light shelves
  - Exterior shading



IEQ Credit 9: Acoustic Environmental/Noise Control

INTENT: Provide appropriate acoustic conditions for user privacy and comfort.

REQUIRMENT: (1 point) Minimize environmental noise through appropriate use of insulation, sound-absorbing materials and noise source isolation.

TECHNOLOGIES/STRATEGIES: Evaluate each occupied environment and determine the appropriate layout, materials, and furnishings design.

IEQ Credit 9: Acoustic Environmental/Noise Control

Additional Strategies:

- Prevent noise transmission by absorbing noise and vibrations at the source.
  - Consider placing vibrating equipment on isolation pads and enclosing equipment in sound-absorbing walls, floors, and ceilings.
  - Place acoustic buffers, such as corridors, lobbies, stairwells, electrical/janitorial closets, and storage rooms, between noise-producing and noise-sensitive spaces.

IEQ Credit 9: Acoustic Environmental/Noise Control

- Prevent transmission of sound through the building structure through use of floating floor slabs and sound-insulated penetrations of walls, floors, and ceilings.
- Prevent transmission between exterior and interior by ensuring appropriate fabrication and assembly of walls, windows, roofs, ground floor, and foundations.
- Prevent transmission between rooms by wall, floor, and ceiling assemblies by specifying materials with appropriate sound transmission class ratings.
- Situate mechanical room doors across from non-critical building areas.

IEQ Credit 9: Acoustic Environmental/Noise Control

- Consider using set-off studs with sound-attenuating insulation, floating floor slabs, and sound-absorbent ceiling systems.
- Consider the use of sound-rated acoustic doors or exhaust air discharge openings near windows, doors, or vents where noise can re-enter the building.
- Consider wrapping or enclosing rectangular ducts with sound isolation materials.
- Consider the use of sound attenuators (duct silencers or sound traps) and acoustic plenums to reduce noise in ductwork.

IEQ Credit 10: Facility In-Use IAQ Management Plan

INTENT: Insure the effective management of facility air quality during its life.

REQUIRMENT: (1 point) Perform all of the following:

Develop an air quality action plan to include scheduled HVAC system cleaning.

Develop an air quality action plan to include education of occupants and facility managers on indoor pollutants and their roles in preventing them.

more . . .

IEQ Credit 10: Facility In-Use IAQ Management Plan

Develop an air quality action plan to include permanent monitoring of supply and return air, and ambient air at the fresh air intake, for carbon monoxide (CO), carbon dioxide (CO 2), total volatile organic compounds (TVOCs), and particulates (including PM10).

TECHNOLOGIES/STRATEGIES: Provide action plan for periodic system maintenance, monitoring, occupant/manager training.

References and Resources

- www.epa.gov/iaq
- www.fire.nist.gov/bfrlpubs/build94/PDF/b94024.pdf
- www.epa.gov/rtp/new-bldg/environmental/s_01445.htm
- www.buildinggreen.com/elists/halpaper.html
- www.rochestermidland.com/division/institut/ghouse.html
- www.fmlink.com.au/images.au/Papers/bauman.htm
- www.edcmag.com/CDA/ArticleInformation/coverstory/BNPCoverStoryItem/0,4118,19794,00.html
- www.ashrae.org
- Eande.lbl.gov/BTP/pub/designguide/download.html